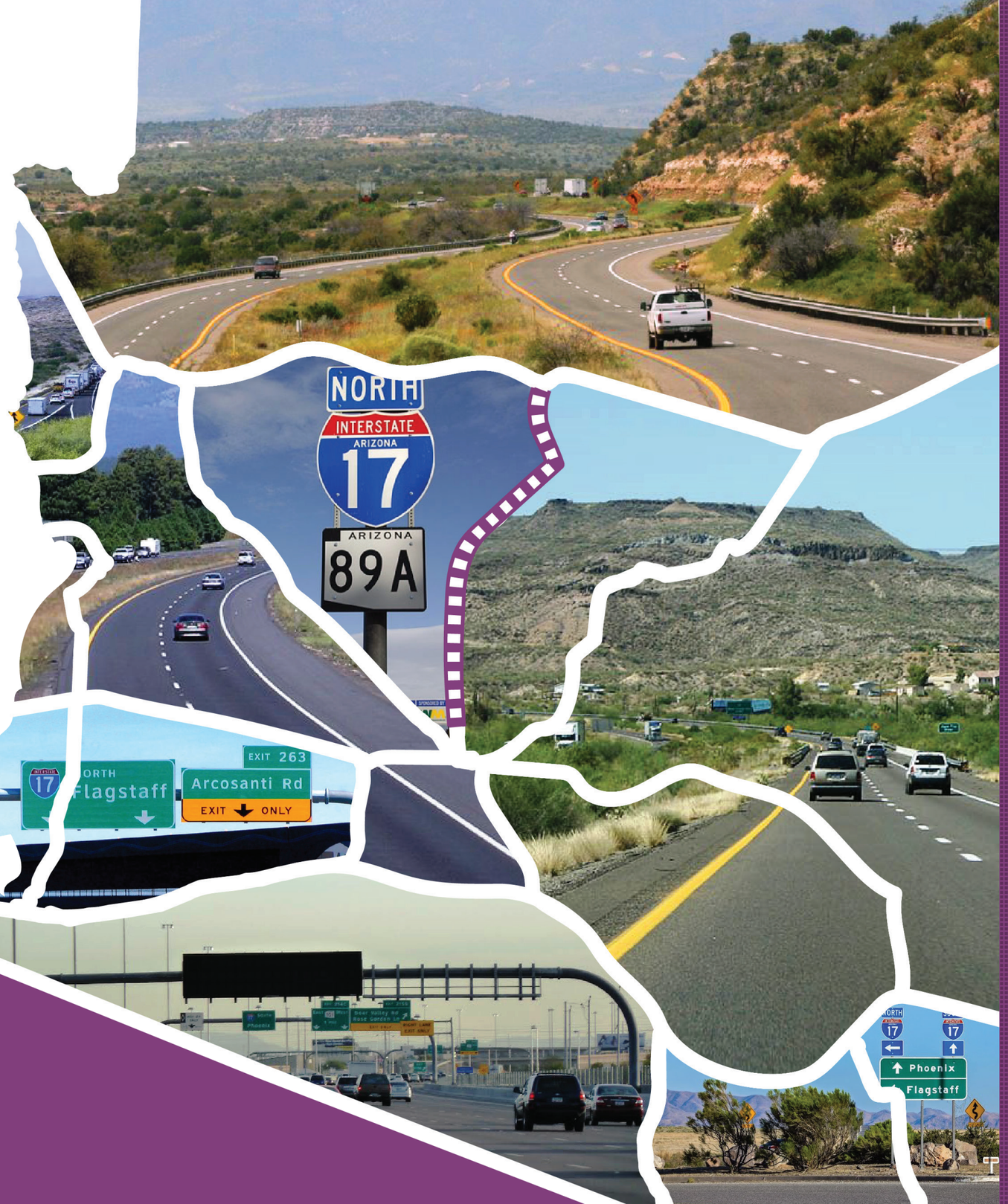
FINAL REPORT

EXECUTIVE SUMMARY

# I-17 Corridor Profile Study

*SR 101L to I-40*

PREPARED FOR ADOT MARCH 2017

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# *EXECUTIVE SUMMARY*

## INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of Interstate 17 (I-17) between the cities of Phoenix (SR 101L) and Flagstaff (I-40). This study examines key performance measures relative to the I-17 Corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT is conducting eleven CPS within three separate groupings. The I-17 Corridor, depicted in **Figure ES-1**, is one of the strategic statewide corridors identified and the subject of this CPS.

**Corridor Study Purpose, Goals and Objectives**

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

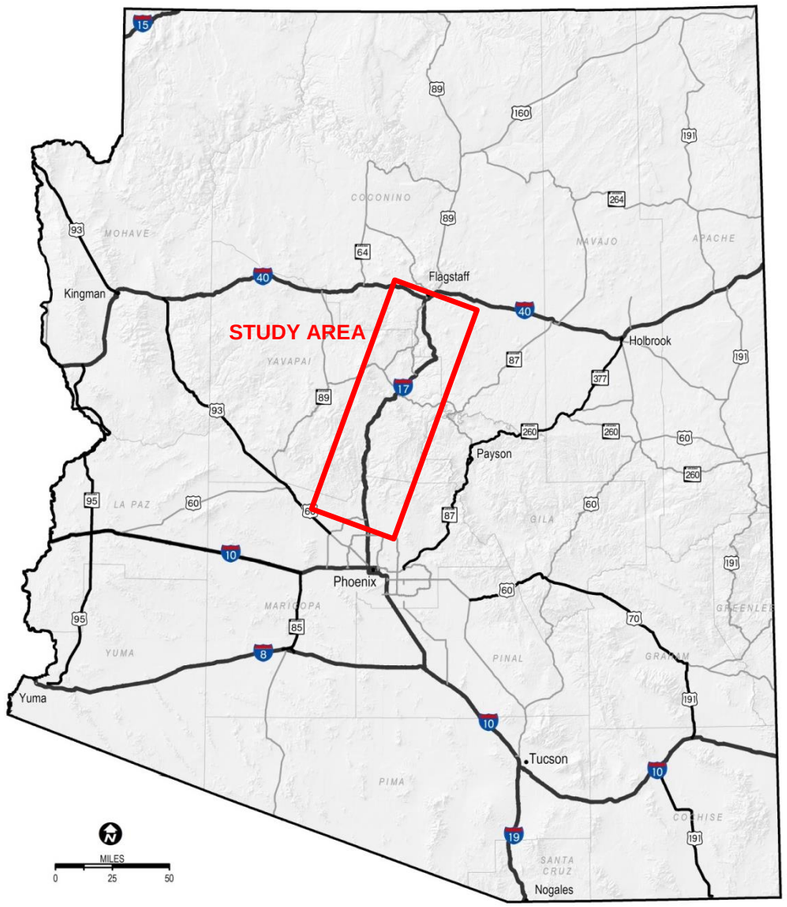
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-17 CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals are identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

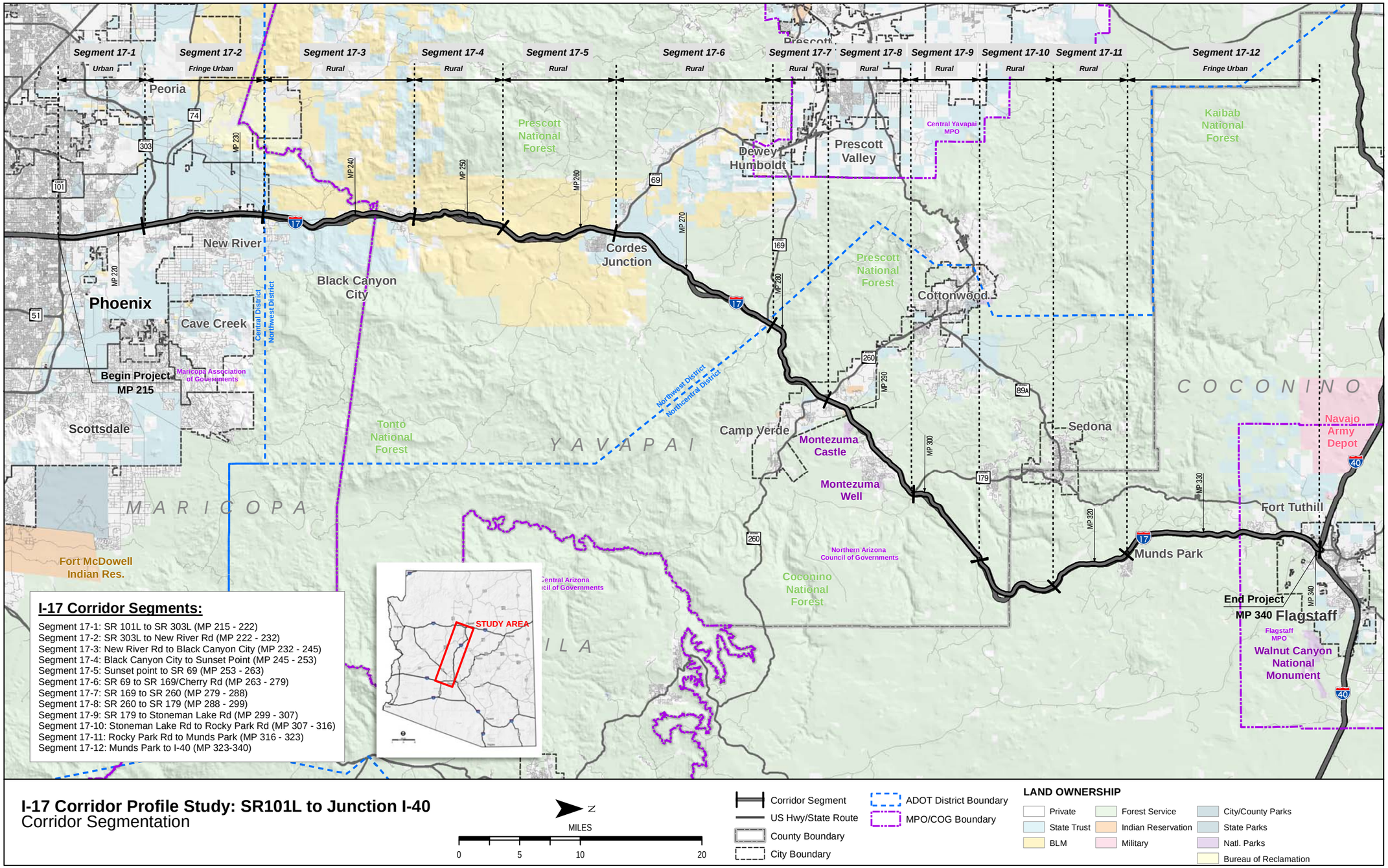
**Figure ES-1: Corridor Study Area**




**Study Location and Corridor Segments**

The I-17 Corridor is divided into 12 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES-2**.

## Figure ES-2: Corridor Location and Segments



## CORRIDOR PERFORMANCE

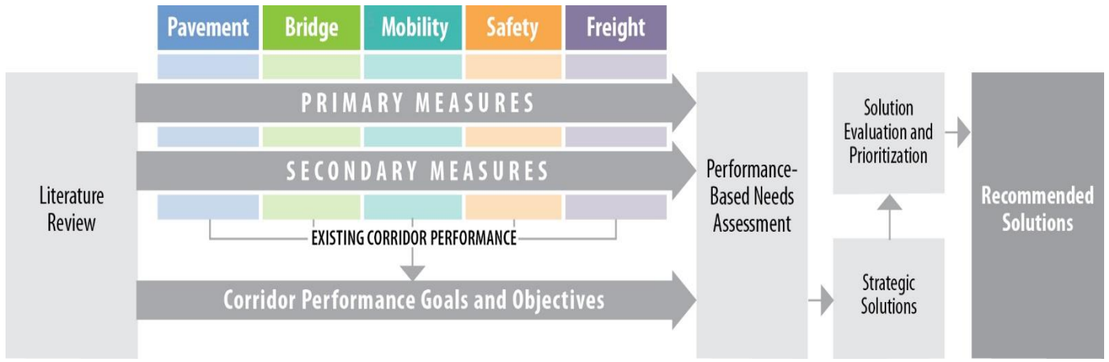
A series of performance measures is used to assess the I-17 corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

### Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

**Figure ES-3** illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

**Figure ES-3: Corridor Profile Performance Framework**




The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

**Table ES-1: Corridor Performance Measures**

| Performance Area | Primary Measure | Secondary Measures |
|---|---|---|
| **Pavement** | **Pavement Index**<br>Based on a combination of International Roughness Index and Cracking | • Directional Pavement Serviceability<br>• Pavement Failure<br>• Pavement Hot Spots |
| **Bridge** | **Bridge Index**<br>Based on lowest of deck, substructure, superstructure and structural evaluation rating | • Bridge Sufficiency<br>• Functionally Obsolete Bridges<br>• Bridge Rating<br>• Bridge Hot Spots |
| **Mobility** | **Mobility Index**<br>Based on combination of existing and future daily volume-to-capacity ratios | • Future Congestion<br>• Peak Congestion<br>• Travel Time Reliability<br>• Multimodal Opportunities |
| **Safety** | **Safety Index**<br>Based on frequency of fatal and incapacitating injury crashes | • Directional Safety Index<br>• Strategic Highway Safety Plan Emphasis Areas<br>• Crash Unit Types<br>• Safety Hot Spots |
| **Freight** | **Freight Index**<br>Based on bi-directional truck planning time index | • Recurring Delay<br>• Non-Recurring Delay<br>• Closure Duration<br>• Bridge Vertical Clearance<br>• Bridge Vertical Clearance Hot Spots |

Each of the primary and secondary performance measures identified in the table above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating falls within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

The terms “good”, “fair”, and “poor” apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms “above average”, “average”, and “below average” apply to the Safety performance measures, which have thresholds referenced to statewide averages.

**Corridor Performance Summary**

**Table ES-2** shows a summary of corridor performance for all primary measures and secondary measure indicators for the I-17 Corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

Approximately 81% of the corridor shows “good” performance in the Pavement Index. For the Bridge Index, 34% of the corridor shows “good” performance, and 66% shows “fair” performance. Approximately 70% of the corridor shows “good”, 25% “fair” and 5% “poor” performance in Mobility. Over one-third of the corridor (36%) for the Safety Index shows “below average” performance, while the remaining 64% of the corridor shows “fair” performance. For the Freight Index, approximately 60% of the corridor shows “good” performance while 40% shows “fair” performance.

The lowest performance along the I-17 Corridor occurs in the Safety and Bridge Performance Areas while the Pavement and Mobility Performance Areas showing the highest performance.

The following general observations were made related to the I-17 Corridor:

- The bridges and pavement are generally in “good” or “fair” condition with the exception of a few isolated locations
- The McGuireville TI is a structurally deficient bridge, has a low Sufficiency Rating, and has a sub-standard vertical clearance which obstructs freight movement since the southbound exit ramp is a loop ramp and does not allow trucks to by-pass the restriction
- Currently, the general mobility along the corridor is “good” (during a typical weekday) but projected traffic growth is expected to result in “poor” or “fair” performance in approximately 45% of the corridor (at the south end and in the middle of the corridor) by the year 2035
- There are several locations along the corridor where recurring and non-recurring delays show either “fair” or “poor” performance, primarily due to uphill grades, as reflected in both the Mobility and Freight Performance Areas
- Currently, the freight mobility along the corridor is “good” with a few spot locations that show “fair” performance primarily due to uphill grades
- The frequency of closures along the corridor generally match the statewide average with the exception of segments 17-3 and 17-4 which exceed the statewide average
- The duration of closures along the corridor generally match the statewide average with the exception of segments 17-1, 17-3, and 17-4 which exceed the statewide average
- A majority of the segments perform either “average” or “below average” in the Safety Index

## Table ES-2: Corridor Performance Summary by Segment and Performance Measure

| Segment | Segment Length (miles) | Pavement Performance Area | | | | Bridge Performance Area | | | | Mobility Performance Area | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pavement Index | Directional PSR | | % Area Failure | Bridge Index | Sufficiency Rating | Lowest Bridge Rating | % of Deck Area on Functionally Obsolete Bridges | Mobility Index | Future Daily V/C | Existing Peak Hour V/C | | Closure Extent (instances/milepost/year/mile) | | Directional TTI (all vehicles) | | Directional PTI (all vehicles) | | % Bicycle Accommodation | % Non-Single Occupancy Vehicle (SOV) Trips |
| | | | NB | SB | | | | | | | | NB | SB | NB | SB | NB | SB | NB | SB | | |
| 17-1[1] | 7 | 4.19 | 4.24 | 4.14 | 0.0% | 6.98 | 91.52 | 5 | 23.8% | 0.90 | 1.09 | 0.67 | 0.67 | 0.41 | 0.03 | 1.00 | 1.00 | 1.03 | 1.03 | 99% | 10.7% |
| 17-2[1] | 10 | 4.16 | 4.13 | 4.15 | 0.0% | 6.79 | 92.73 | 6 | 14.6% | 0.68 | 0.80 | 0.51 | 0.53 | 0.41 | 0.00 | 1.08 | 1.05 | 1.15 | 1.11 | 100% | 12.3% |
| 17-3[2] | 13 | 3.85 | 3.92 | 3.86 | 3.8% | 6.39 | 91.10 | 5 | 31.3% | 0.58 | 0.71 | 0.40 | 0.40 | 0.78 | 0.11 | 1.09 | 1.11 | 1.17 | 1.20 | 100% | 12.0% |
| 17-4[2] | 8 | 4.25 | 3.65 | 4.25 | 0.0% | 5.71 | 93.97 | 5 | 60.9% | 0.64 | 0.78 | 0.38 | 0.38 | 0.75 | 0.61 | 1.21 | 1.00 | 1.61 | 1.07 | 97% | 12.3% |
| 17-5[2] | 10 | 4.25 | 4.09 | 4.02 | 0.0% | 7.15 | 96.27 | 6 | 16.9% | 0.59 | 0.72 | 0.38 | 0.40 | 0.42 | 0.28 | 1.20 | 1.14 | 1.34 | 1.21 | 100% | 15.5% |
| 17-6[2] | 16 | 4.26 | 4.08 | 4.02 | 0.0% | 6.19 | 94.82 | 5 | 8.5% | 0.37 | 0.45 | 0.33 | 0.33 | 0.05 | 0.15 | 1.13 | 1.38 | 1.23 | 1.69 | 100% | 7.7% |
| 17-7[2] | 9 | 3.92 | 3.78 | 3.93 | 16.7% | 6.31 | 91.41 | 6 | 0.0% | 0.55 | 0.68 | 0.47 | 0.48 | 0.27 | 0.11 | 1.09 | 1.15 | 1.27 | 1.31 | 98% | 7.7% |
| 17-8[2] | 11 | 4.32 | 4.01 | 4.17 | 4.5% | 6.04 | 89.20 | 4 | 13.6% | 0.39 | 0.47 | 0.35 | 0.35 | 0.15 | 0.22 | 1.14 | 1.13 | 1.27 | 1.24 | 100% | 14.1% |
| 17-9[2] | 8 | 4.21 | 3.77 | 4.18 | 18.8% | 6.00 | 93.00 | 6 | 100.0% | 0.41 | 0.49 | 0.32 | 0.32 | 0.35 | 0.20 | 1.30 | 1.12 | 1.61 | 1.22 | 100% | 6.6% |
| 17-10[2] | 9 | 4.19 | 4.01 | 4.06 | 0.0% | 6.52 | 94.00 | 6 | 100.0% | 0.35 | 0.41 | 0.27 | 0.27 | 0.20 | 0.29 | 1.29 | 1.13 | 1.60 | 1.25 | 100% | 6.3% |
| 17-11[2] | 7 | 3.73 | 3.50 | 3.82 | 21.4% | 6.91 | 96.48 | 5 | 3.4% | 0.29 | 0.34 | 0.23 | 0.21 | 0.00 | 0.29 | 1.10 | 1.08 | 1.18 | 1.16 | 100% | 6.2% |
| 17-12[1] | 17 | 3.70 | 3.49 | 3.82 | 25.7% | 5.80 | 92.00 | 5 | 62.3% | 0.29 | 0.34 | 0.18 | 0.18 | 0.07 | 0.31 | 1.06 | 1.05 | 1.13 | 1.11 | 94% | 17.9% |
| **Weighted Corridor Average** | | 4.07 | 3.88 | 4.02 | 7.9% | 6.34 | 92.94 | 5.28 | 35.6% | 0.48 | 0.58 | 0.36 | 0.36 | 0.30 | 0.21 | 1.13 | 1.13 | 1.28 | 1.24 | 98.8% | 11.3% |

**SCALES**

| Performance Level | Interstate | | All | | | | Urban | All | Uninterrupted | | All | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Good/Above Average | > 3.75 | < 5% | > 6.5 | > 80 | > 6 | < 12% | < 0.71 | < 0.22 | < 1.15 | <1.30 | > 90% | > 17% |
| Fair/Average | 3.2 - 3.75 | 5% - 20% | 5.0 - 6.5 | 50 - 80 | 5 – 6 | 12% - 40% | 0.71 - 0.89 | 0.22 – 0.62 | 1.15-1.33 | 1.30-1.50 | 60% - 90% | 11% - 17% |
| Poor/Below Average | < 3.2 | > 20% | < 5.0 | < 50 | < 5 | > 40 % | > 0.89 | > 0.62 | > 1.33 | >1.50 | < 60% | < 11% |

| Performance Level | Rural |
|---|---|
| Good/Above Average | < 0.56 |
| Fair/Average | 0.56 - 0.76 |
| Poor/Below Average | > 0.76 |

1: Urban or Fringe Urban
2: Rural

## Table ES-2: Corridor Performance Summary by Segment and Performance Measure (continued)

| Segment | Segment Length (miles) | Safety Performance Area | | | | | | Freight Performance Area | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Safety Index | Directional Safety Index | | % of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors | % of Fatal + Incapacitating Injury Crashes Involving Trucks | % of Fatal + Incapacitating Injury Crashes Involving Motorcycles | % of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers | Freight Index | Directional TTTI | | Directional TPTI | | Closure Duration (mins/milepost/year/mile) | | Bridge Vertical Clearance (feet) |
| | | | NB | SB | | | | | | NB | SB | NB | SB | NB | SB | |
| 17-1[a] | 7 | 1.13 | 1.03 | 1.24 | 0% | 6% | 12% | Insufficient Data | 0.94 | 1.03 | 1.03 | 1.07 | 1.07 | 134.0 | 4.5 | 16.80 |
| 17-2[b] | 10 | 1.67 | 1.51 | 1.83 | 31% | 11% | 9% | Insufficient Data | 0.95 | 1.02 | 1.00 | 1.06 | 1.04 | 108.5 | 0.0 | 16.23 |
| 17-3[c] | 13 | 0.75 | 0.84 | 0.67 | 69% | 10% | 17% | Insufficient Data | 0.94 | 1.01 | 1.03 | 1.04 | 1.09 | 209.8 | 19.7 | 16.01 |
| 17-4[c] | 8 | 1.06 | 0.49 | 1.64 | 35% | 12% | 29% | Insufficient Data | 0.67 | 1.34 | 1.07 | 1.81 | 1.16 | 194.0 | 175.3 | 16.29 |
| 17-5[c] | 10 | 1.01 | 1.36 | 0.65 | 35% | 10% | 15% | Insufficient Data | 0.88 | 1.09 | 1.02 | 1.20 | 1.07 | 120.0 | 49.4 | 18.22 |
| 17-6[d] | 16 | 1.32 | 1.09 | 1.55 | 56% | 6% | 17% | Insufficient Data | 0.74 | 1.03 | 1.27 | 1.08 | 1.61 | 13.6 | 24.9 | 16.85 |
| 17-7[c] | 9 | 0.85 | 0.98 | 0.72 | 47% | Insufficient Data | 13% | Insufficient Data | 0.75 | 1.07 | 1.27 | 1.15 | 1.52 | 64.0 | 20.7 | 16.91 |
| 17-8[d] | 11 | 2.54 | 3.00 | 2.08 | 58% | 16% | 5% | Insufficient Data | 0.88 | 1.08 | 1.05 | 1.15 | 1.11 | 32.7 | 44.2 | 15.18 |
| 17-9[d] | 8 | 2.18 | 2.39 | 1.97 | 48% | 10% | 0% | Insufficient Data | 0.75 | 1.29 | 1.06 | 1.55 | 1.13 | 122.5 | 107.0 | No UP |
| 17-10[d] | 9 | 0.86 | 0.81 | 0.91 | 50% | Insufficient Data | Insufficient Data | Insufficient Data | 0.74 | 1.25 | 1.07 | 1.57 | 1.15 | 41.7 | 121.2 | No UP |
| 17-11[d] | 7 | 1.21 | 2.19 | 0.24 | 29% | 7% | 7% | Insufficient Data | 0.94 | 1.03 | 1.02 | 1.07 | 1.06 | 0.0 | 124.4 | 16.87 |
| 17-12[d] | 17 | 1.04 | 0.53 | 1.54 | 33% | 4% | 8% | Insufficient Data | 0.93 | 1.05 | 1.03 | 1.10 | 1.06 | 12.6 | 122.3 | 16.51 |
| Weighted Corridor Average | | 1.29 | 1.29 | 1.29 | 43.1% | 8.9% | 12.1% | Insufficient Data | 0.85 | 1.09 | 1.08 | 1.21 | 1.19 | 81.8 | 65.2 | 16.56 |

**SCALES**

| Performance Level | Urban >6 Lane Freeway | | | | | Uninterrupted | | | All | |
|---|---|---|---|---|---|---|---|---|---|---|
| Good/Above Average | < 0.80 | < 42.6% | < 2.5% | < 12.6% | - | > 0.77 | < 1.15 | < 1.30 | < 44.18 | > 16.5 |
| Fair/Average | 0.80 – 1.20 | 42.6% - 54.8% | 2.5% - 6.0% | 12.6% - 20.0% | - | 0.67 - 0.77 | 1.15 -1.33 | 1.30 -1.50 | 44.18 -124.86 | 16.0-16.5 |
| Poor/Below Average | > 1.20 | > 54.8% | > 6.0% | > 20.0% | - | < 0.67 | > 1.33 | >1.50 | > 124.86 | < 16.0 |
| **Performance Level** | **Urban or Rural 6 Lane Freeway** | | | | | | | | | |
| Good/Above Average | < 0.82 | < 33.5% | < 6.2% | < 6.7% | - | | | | | |
| Fair/Average | 0.82 – 1.18 | 33.5% - 57.2% | 6.2% - 11.0% | 6.7% - 12.9% | - | | | | | |
| Poor/Below Average | > 1.18 | > 57.2% | > 11.0% | > 12.9% | - | | | | | |
| **Performance Level** | **Rural 4 Lane Freeway > 25,000 vpd** | | | | | | | | | |
| Good/Above Average | < 0.68 | < 40.8% | < 7.2% | < 7.7% | - | | | | | |
| Fair/Average | 0.68 – 1.32 | 40.8% - 57.1% | 7.2% - 12.9% | 7.7% - 17.1% | - | | | | | |
| Poor/Below Average | > 1.32 | > 57.1% | > 12.9% | > 17.1% | - | | | | | |
| **Performance Level** | **Rural 4 Lane Freeway < 25,000 vpd** | | | | | | | | | |
| Good/Above Average | < 0.73 | < 42.8% | < 13.2% | < 5.0% | - | | | | | |
| Fair/Average | 0.73 – 1.27 | 42.8% - 52.9% | 13.2% - 17.0% | 5.0% - 8.5% | - | | | | | |
| Poor/Below Average | > 1.27 | > 52.9% | > 17.0% | > 8.5% | - | | | | | |

a: Urban >6 Lane Freeway b: Urban or Rural 6 Lane Freeway c: Rural 4 Lane Freeway > 25,000 vpd d: Rural 4 Lane Freeway < 25,000 vpd

*Notes: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings "No UP" indicates no underpasses are present in the segment*

## NEEDS ASSESSMENT

### Corridor Description

The I-17 Corridor is and will continue to be a major transportation corridor for commuting, commerce, and tourism. I-17 is primarily a 4-lane divided freeway from New River Road through I-40 with 4-8 divided lanes and HOV lanes in the urban segments of the corridor between SR 101L and New River Road. ADOT has designated this section of I-17 as a Key Commerce Corridor and as part of the National Primary Freight Network. I-17 provides the most direct and fastest link between Phoenix (and I-10) and Flagstaff (and I-40) and provides a principal road link for national and international traffic from Phoenix Sky Harbor International Airport to Prescott, the Verde Valley, Sedona, Flagstaff, the Grand Canyon, and the Navajo and Hopi nations.

### Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to I-17 performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, two "Emphasis Areas" were identified for the I-17 Corridor: Mobility and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor.

Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

### Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in **Figure ES-5**.

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

**Figure ES-4: Needs Assessment Process**

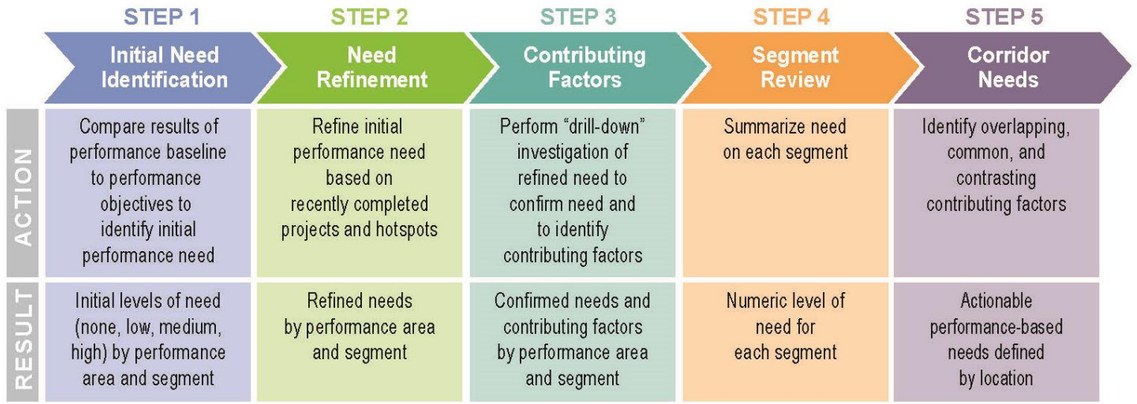



**Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)**

| Performance Thresholds | Performance Level | Initial Level of Need | Description |
|---|---|---|---|
| 6.5 | Good | None | All levels of Good and top 1/3 of Fair (>6.0) |
| | Good | | |
| | Good | | |
| | Fair | | |
| 5.0 | Fair | Low | Middle 1/3 of Fair (5.5-6.0) |
| | Fair | Medium | Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5) |
| | Poor | | |
| | Poor | High | Lower 2/3 of Poor (<4.5) |
| | Poor | | |

**Summary of Corridor Needs**

**Table ES-3** provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Mobility and Safety for the I-17 Corridor). There are no segments with a High average need, nine segments with a Medium average need, and five segments with a Low average need. More information on the identified final needs in each performance area is provided below.

*Pavement Needs*

- Pavement Needs were identified on three segments (17-3, 17-11, and 17-12).
- Programmed pavement rehabilitation projects will likely mitigate two of these segments.
- A high level of historical investment was identified on approximately 72 miles of the corridor, meaning that some projects have proven to provide only temporary improvements and require frequent attention. These locations may be candidates for life-cycle cost analysis to evaluate alternative solutions.

*Bridge Needs*

- Bridge Needs occur due to under-performing bridges or hot spots on nine of the twelve segments.
- Bridge Needs were identified at 16 of the total 98 bridges (16%).
- Projects are programmed at two bridges which could address the Needs at Moores Gulch (southbound) and Willard Springs TI.
- Eleven bridges have current ratings of 5, and one bridge has current rating of 4.
- Eight bridges have potential historical rating issues and may be candidates for life-cycle cost analysis to evaluate alternative solutions.

*Mobility Needs*

- Mobility Needs were identified on nine of the twelve segments (70% of corridor).
- A majority of the Needs are related to future travel demand, directional TTI and PTI issues, and closures.
- "Medium" Mobility Needs were identified on Segment 17-4 primarily due to the grades/terrain and restrictions due to closures.
- The lowest trip reliability is on Segment 17-4 (MP 245-253).

*Safety Needs*

- Safety Needs were identified on all segments along the I-17 Corridor.
- "High" Safety Needs were identified on six of the twelve segments (47% of corridor).
- Multiple safety hot spots were identified, especially in the southern part of the corridor on segments 17-1 through 17-3.
- At the overall corridor level, 62% of the fatal and incapacitating crashes involve either over-turning or colliding with a fixed object, 52% involve run-off-road crashes, and 30% involve speed too fast for conditions.
- While a "High" level of Need was identified on segments 17-1 and 17-2, both of these segments have recently been reconstructed/widened which has changed the operating conditions of these segments and may have addressed some of the safety issues.

*Freight Needs*

- Freight Needs were identified on all segments along the I-17 Corridor.
- All segments show "Low" Need, except on segment 17-4. Other than on segment 17-4, impediments to freight mobility and travel times are not significant.
- Elevated values for TTTI and TPTI are generally shown in the uphill directions of mountainous terrain.
- Closure durations are higher than the statewide average on the southern end (segments 17-1 through 17-5) and the northern end (segments 17-9-17-12) of the corridor.
- Two bridges provide less than 16' vertical clearance and cannot be by-passed by using ramps: Table Mesa Rd TI UP (MP 236 southbound) and McGuireville TI UP (MP 293 southbound)

*Overlapping Needs*

This section identifies overlapping performance needs on the I-17 Corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- MP 245 to 253 (Segment 17-4) has overlapping needs in the Bridge, Mobility, Safety, and Freight performance areas with Medium or High levels of Need in all four areas. The ADOT Northwest District has indicated that this location is a high crash area and has significant mobility issues. This area has substantial grades and is classified as mountainous terrain which is the primary contributing factor to the freight and mobility issues. Mountainous terrain typically creates speed differentials between vehicles and two travel lanes do not supply ample passing opportunities leading to improper lane changes. The ADOT Climbing and Passing Lane Prioritization Study (2015) indicated that the implementation of a climbing lane on this section of the corridor is ranked number 1 on the prioritized list of climbing lanes on multi-lane highways within the state.

**Table ES-3: Summary of Needs by Segment**

| Performance Area | Segment Number and Mileposts | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 17-1 | 17-2 | 17-3 | 17-4 | 17-5 | 17-6 | 17-7 | 17-8 | 17-9 | 17-10 | 17-11 | 17-12 |
| | MP 215-222 | MP 222-232 | MP 232-245 | MP 245-253 | MP 253-263 | MP 263-279 | MP 279-288 | MP 288-299 | MP 299-307 | MP 307-316 | MP 316-323 | MP 323-340 |
| **Pavement** | None | None | Low | None | None | None | None | None | None | None | Low | Low |
| **Bridge** | Low | None | Low | Medium | None | Low | None | Low | Low | Low | Low | Medium |
| **Mobility+** | High | Low | Low | Medium | Low | Low | Low | None | Low | Low | None | None |
| **Safety+** | High | High | Low | Medium | Medium | High | Low | High | High | Low | High | Medium |
| **Freight** | Low | Low | Low | High | Low | Low | Low | Low | Low | Low | Low | Low |
| **Average Need (0-3)** | **2.07** | **1.33** | **1.00** | **1.87** | **1.03** | **1.47** | **0.73** | **1.17** | **1.47** | **0.87** | **1.30** | **1.13** |

** A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

*+ Identified as an emphasis area for the I-17 Corridor.*

| Average Need Scale | |
|---|---|
| None | < 0.1 |
| Low | 0.1 - 1.00 |
| Medium | 1.00 - 2.00 |
| High | > 2.00 |

## STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need as addressing these needs will have the greatest effect on corridor performance. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The I-17 strategic investment areas (resulting from the elevated needs) are shown in **Figure ES-6**.

### Screening Process

In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment issues. These hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need. This bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

### Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-17 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

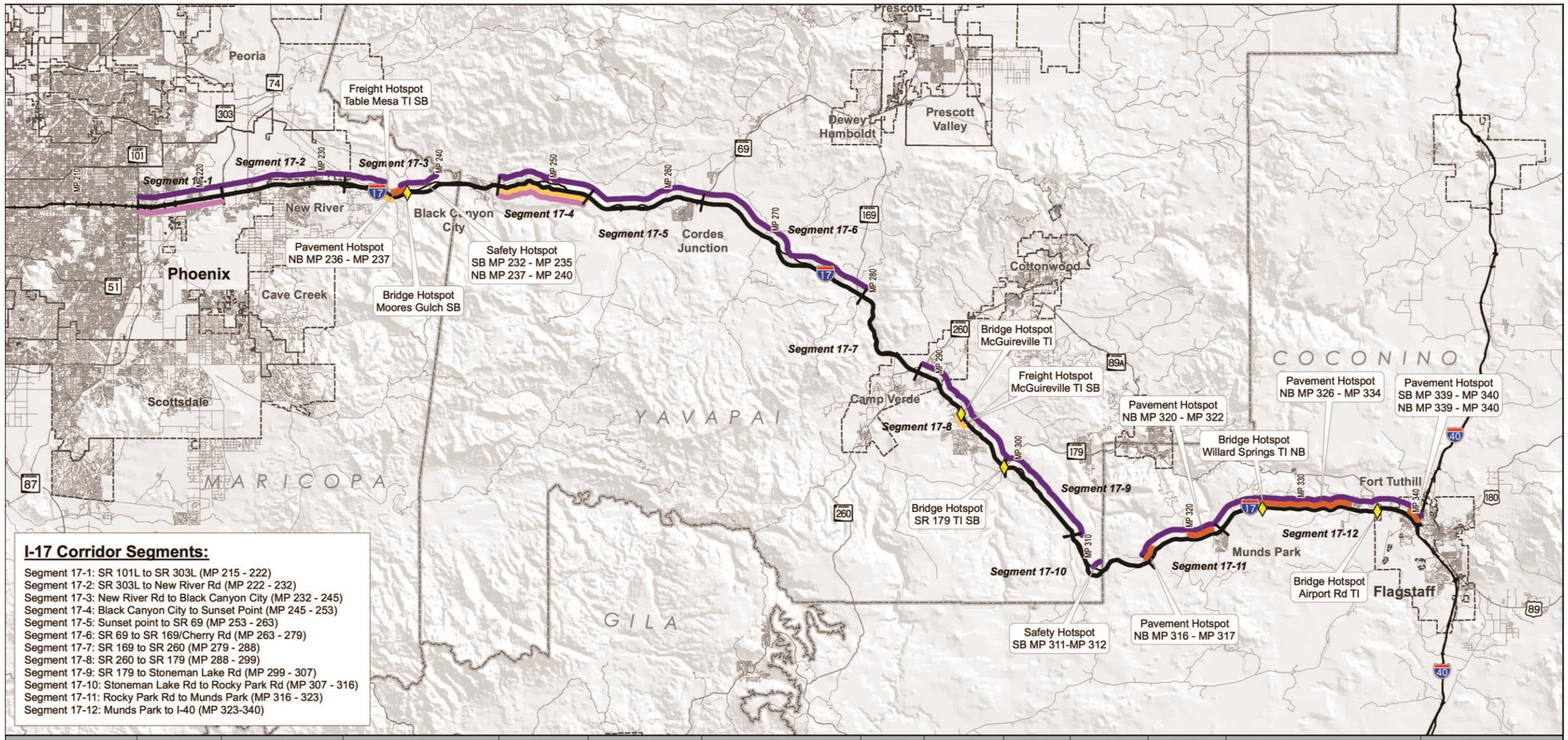
Candidate solutions include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance areas include two options: rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

**Figure ES-6: Strategic Investment Areas**




**I-17 Corridor Segments:**

Segment 17-1: SR 101L to SR 303L (MP 215 - 222)
Segment 17-2: SR 303L to New River Rd (MP 222 - 232)
Segment 17-3: New River Rd to Black Canyon City (MP 232 - 245)
Segment 17-4: Black Canyon City to Sunset Point (MP 245 - 253)
Segment 17-5: Sunset point to SR 69 (MP 253 - 263)
Segment 17-6: SR 69 to SR 169/Cherry Rd (MP 263 - 279)
Segment 17-7: SR 169 to SR 260 (MP 279 - 288)
Segment 17-8: SR 260 to SR 179 (MP 288 - 299)
Segment 17-9: SR 179 to Stoneman Lake Rd (MP 299 - 307)
Segment 17-10: Stoneman Lake Rd to Rocky Park Rd (MP 307 - 316)
Segment 17-11: Rocky Park Rd to Munds Park (MP 316 - 323)
Segment 17-12: Munds Park to I-40 (MP 323-340)

| Segments | 17-1 | 17-2 | 17-3 | 17-4 | 17-5 | 17-6 | 17-7 | 17-8 | 17-9 | 17-10 | 17-11 | 17-12 | Segments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pavement | - | - | Hotspot | - | - | - | - | - | - | - | Hotspot | Hotspot | Pavement |
| Bridge | - | - | Hotspot | Medium | - | - | - | Hotspot | - | - | - | Medium | Bridge |
| Mobility* | High | - | - | Medium | - | - | - | - | - | - | - | - | Mobility* |
| Safety* | High | High | Hotspot | Medium | Medium | High | - | High | High | Hotspot | High | Medium | Safety* |
| Freight | - | - | Hotspot | High | - | - | - | Hotspot | | - | - | - | Freight |
| Average Need (0-3) | 2.07 | 1.33 | 1.00 | 1.87 | 1.03 | 1.47 | 0.73 | 1.17 | 1.47 | 0.87 | 1.30 | 1.13 | Average Need (0-3) |

* Identified as Emphasis Area for I-17 corridor

**I-17 Corridor Profile Study: SR 101L to Junction I-40**
Strategic Investment Areas

0 2.5 5 10 15 20 Miles

**Strategic Investment Areas**
Safety
Pavement
Freight
Mobility
Bridge

**Level of Need**
Low
Medium
High

## SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation is shown in **Figure ES-7** and described more fully below.

### Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

All Mobility, Safety, and Freight strategic investment areas that result in multiple independent candidate solutions are advanced directly to the Performance Effectiveness Evaluation.

### Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

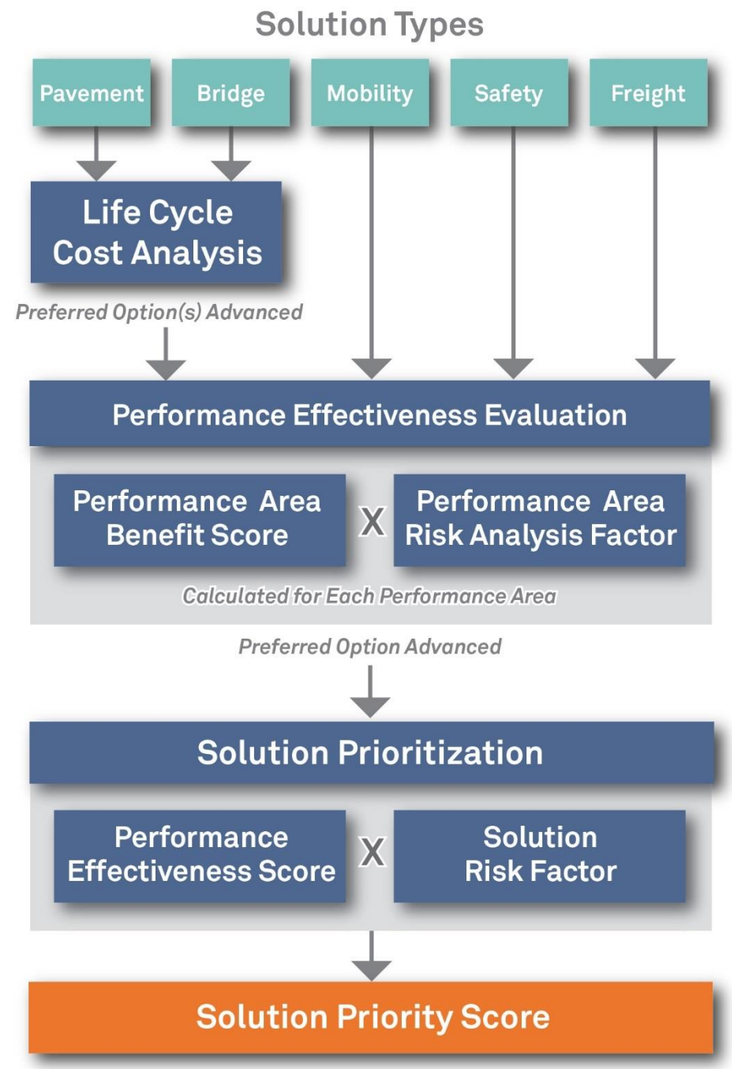
### Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure.

### Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

**Figure ES-7: Candidate Solution Evaluation Process**



## SUMMARY OF CORRIDOR RECOMMENDATIONS

### Prioritized Candidate Solution Recommendations

**Table ES-4** and **Figure ES-8** show the prioritized candidate solutions recommended for the I-17 Corridor. Implementation of these solutions is anticipated to improve performance of the I-17 Corridor across a majority of the performance areas.

### Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the I-17 Corridor:

- Conduct study to investigate paving roadway along existing dirt roads connecting Bumble Bee Rd (MP 248) to Bloody Basin Rd (MP 259) for use during closures, similar to N20 interim detour for US 89.
- Continue to provide additional driver messaging and emphasis on safety during holiday weekends.
- The scoping and design of project H893401C (Coconino County Line to I-40)(FY 18) should investigate safety improvements such as installing high visibility striping and delineators, raised pavement markers, rumble strips and widening/rehabilitating the inside (median) shoulder in both directions of travel.
- When recommending future projects along I-17, review historical ratings and levels of investment. According to data used for this study, the following pavement and bridge locations have exhibited high historical investment (pavement) or rating fluctuation (bridge) issues:
  - I-17 OP @ Frt Rd SB #2180 (MP 215)
  - Pavement MP 215 – MP 222
  - Pavement MP 222 – MP 232
  - Moores Gulch SB #339 (MP 238.6)
  - Pavement MP 253 – MP 263
  - Dugas Rd TI SB #1080 (MP 268.75)
  - Cienga Creek NB #428 (MP 277.93)
  - Middle Verde Rd TI #1733 (MP 289.97)
  - Pavement MP 288 – MP 299
  - Pavement MP 299 – MP 307
  - Pavement MP 307 – MP 316
  - McGuireville TI #652 (MP 293.26)
  - Pavement MP 323 – MP 340
  - Willard Springs TI NB #1583 (MP 326)
  - Airport Rd TI #632 (MP 337.39)

### Policy and Initiatives Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through the CPS process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on I-17, but across the entire state highway system where conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects; in pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data

- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network

**Next Steps**

Candidate solutions developed for the I-17 Corridor will be considered along with other candidate projects in the ADOT statewide programming process. It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

Upon completion of all three CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

## Table ES-4: Prioritized Recommended Solutions

| Rank | Candidate Solution # | Option | Solution Name and Location | Description / Scope | Estimated Cost (in millions) | Investment Category Preservation [P] Modernization [M] Expansion [E] | Prioritization Score |
|---|---|---|---|---|---|---|---|
| 1 | CS17.03 | - | Black Canyon Hill Southbound Safety Improvements (SB MP 245 -251) | Enhance roadside design (replace guardrail). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Excavate/grade cut slopes to improve sight distance. Install dynamic speed feedback system on southbound roadway (near MP 248 & MP 251). | $3.15 | M | 176 |
| 2 | CS17.15 | - | Rattlesnake Canyon Northbound Safety Improvements (NB MP 305-307) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Install dynamic speed feedback system. Construct/extend northbound parallel entrance ramp at Stoneman Lake TI. Install CCTV near MP 306.5. | $2.25 | M | 151 |
| 3 | CS17.04 | - | Sunset Point Safety Improvements (MP 252-253) | Construct/ extend parallel northbound and southbound exit ramps at Sunset Point TI. Install roadway weather information systems (RWIS). Install dynamic wind warning system. | $2.47 | M | 99 |
| 4 | CS17.14 | - | Hog Tank Canyon Southbound SB Safety Improvements (SB MP 300-302) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Install dynamic speed feedback system. Excavate/grade cut slopes to improve sight distance. | $4.03 | M | 74 |
| 5 | CS17.11 | - | McGuireville Rest Area Safety Improvements (SB MP 295-299) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Install dynamic speed feedback system near MP 297 and MP 299. Install CCTV on existing DMS located at MP 297.4. | $4.73 | M | 63 |
| 6 | CS17.06 | - | Orme Rd Southbound Safety Improvements (SB MP 269-274) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Install dynamic speed feedback system near MP 272 & 274. | $4.72 | M | 52 |
| 7 | CS17.02 | A | Black Canyon Hill Mobility & Freight Improvements (MP 245-251) | Construct northbound climbing lane and replace southbound Bumble Bee Rd Bridge. | $47.57 | M | 41 |
| | | B | | Construct reversible lanes and replace southbound Bumble Bee Rd Bridge. | $146.22 | M | 29 |
| 8 | CS17.08 | - | Middle Verde Rd Northbound Safety Improvements (NB MP 290-293) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install high visibility striping and delineators, raised pavement markers, and rumble strips. Install chevrons on curves. Install dynamic speed feedback system near MP 291 & MP 293. Install CCTV near existing DMS located at MP 289. | $3.83 | M | 32 |
| 9 | CS17.01 | - | Table Mesa TI Vertical Clearance Mitigation (MP 236) | Re-profile southbound roadway | $2.41 | M | 18 |

## Table ES-4: Prioritized Recommended Solutions (continued)

| Rank | Candidate Solution # | Option | Solution Name and Location | Description / Scope | Estimated Cost (in millions) | Investment Category Preservation [P] Modernization [M] Expansion [E] | Prioritization Score |
|---|---|---|---|---|---|---|---|
| 10 | CS17.12 | - | SR 179 TI Safety Improvements (MP 299) | Construct/extend parallel southbound entrance and northbound exit ramps at SR179 TI. | $2.22 | M | 12 |
| 11 | CS17.05 | - | Badger Springs Northbound Climbing Lane (NB MP 256-260) | Construct northbound climbing lane. | $14.90 | M | 12 |
| 12 | CS17.13 | - | Hog Tank Canyon NB Climbing Lane (NB MP 299-305) | Construct northbound climbing lane. Install new DMS at MP 303.4 with CCTV. | $23.06 | M | 11 |
| 13 | CS17.10 | - | Dry Beaver Creek NB Climbing Lane (NB MP 294-298) | Construct northbound climbing lane | $14.90 | M | 11 |
| 14 | CS17.16 | - | Red Hill Scenic Overlook Southbound Safety Improvements (SB MP 309-313) | Improve skid resistance (reconstruct pavement, increase super-elevation, or mill and replace). Install chevrons on curves. Install dynamic speed feedback system near MP 311 and MP 313. Install CCTV near MP 312.3. | $7.23 | M | 9 |
| 15 | CS17.07 | A | McGuireville TI Bridge (MP 293.25-293.75) | Rehabilitate/repair McGuireville TI bridge and construct new southbound exit ramp | $7.79 | M | 6 |
| | | B | | Replace McGuireville TI bridge | $18.86 | M | 5 |
| 16 | CS17.18 | - | Woods Canyon Safety Improvements (MP 316.5-317.5) | Realign roadway and construct new bridges over Woods Canyon with de-icing system. Install roadway weather information system (RWIS) near Rocky Park TI or Woods Canyon. | $36.28 | M | 5 |
| 17 | CS17.09 | - | Dry Beaver Creek SB Climbing Lane (SB MP 292-294) | Construct southbound climbing lane and widen Dry Beaver Creek Bridge | $9.35 | M | 1 |
| 18 | CS17.17 | - | Woods Canyon Southbound Climbing Lane (SB MP 316-317) | Construct southbound climbing lane | $5.60 | M | 1 |

## Figure ES-8: Prioritized Recommended Solutions